

REMARKS

Claims 1-18 were pending at the time of rejection. Claims 1-4 were rejected and claims 5-18 were withdrawn from consideration.

With respect to checking the specification, Applicants have not advised that they are aware of any possible minor errors in the specification. However, if the Examiner does note an error of some type that the Examiner believes warrants correction, the undersigned will check the specification upon a telephonic request from the Examiner.

Turning first to **Election/Restrictions**, Applicants affirm their election of Group I, claims 1-4, without traverse.

Prior art considered: U.S. Patent 6,267,943 Manev et al (Manev); JP 11-071115 Iwata et al (Iwata).

The rejections:

Claims 1-4 are rejected under 35 U.S.C. § 102(e) as anticipated by Manev. Paragraph 1 of the Action.

Claims 1-4 are also rejected as anticipated by Iwata in view of Manev. Paragraph 2 of the Action.

The above rejections are respectfully traversed.

Traversal

Applicants first turn to the anticipation rejection based on Manev.

Manev discloses $\text{Li}_{1+x}\text{Mn}_{2-y}\text{M}^1_{m1}\text{M}^2_{m2}\dots\text{M}^k_{mk}\text{O}_{4+z}$, wherein $\text{M}^1, \text{M}^2, \dots, \text{M}^k$ are metals different from lithium or manganese selected from the group consisting of alkaline earth metals,

transition metals, B, Al, Si, Ga and Ge; X, Y, m_1 , m_2 , ... m_k each has a value between 0 and 0.2; Z has a value between -0.1 and 0.2; and X, Y, m_1 , m_2 ... m_k are selected to satisfy the equation:
 $Y=X+m_1+m_2+\dots+m_k$.

The present invention relates to a lithium-manganese complex oxide, which is represented by the formula: $\text{Li}[\text{Mn}_{2-X-Y}\text{Li}_X\text{M}_Y]\text{O}_{4+\delta}$, wherein M is at least one element selected from groups IIa, IIIb and VIII of the 2nd and 3rd periods, and $0.02 \leq X \leq 0.10$, $0.05 \leq Y \leq 0.30$ and $-0.2 \leq \delta \leq 0.2$.

When the present invention is compared with Manev, M falls within the scope of metals as described in Manev; X is a numeral which has the same meaning as X as described in Manev, and the X value range of 0.02 to 0.10 according to the present invention falls within the scope of 0.0 to 0.2 as described in Manev; and although X+Y according to the present invention has the same meaning as Y as described in Manev X+Y according to the present invention represents a range between 0.025 and 0.40, which overlaps with the Y range of 0.025 to 0.2 among 0 to 0.2 as described in Manev.

Despite the seeming similarity between Manev and the present invention, Applicants believe it quite clear that Manev does not anticipate the present claims, as now explained.

A spinel compound is generally represented by the formula: AB_2O_4 . In the present invention, Li_X which represents a surplus portion of Li is present in the B site of the above general formula, whereas Manev does not disclose or suggest in any fashion that Li_X is present in the B site.

Further, Manev essentially discloses LiMn_2O_4 and is silent regarding a lithium-manganese complex oxide having a spinel structure containing a metal (hereinafter referred to as "M") other than Li and Mn according to the present invention. In Fig. 6 and Fig. 7 cited by the Examiner, although the formula: $\text{Li}_{1.03}\text{Mn}_{1.96}\text{Co}_{0.01}\text{O}_4$ is presented in Manev, CO represents a carbonyl group, which group is entirely different from M, such formula would not represent any lithium-manganese complex oxide having a spinel structure containing M in accordance with the present invention.

Accordingly, Applicants respectfully submit, taking the claims of Manev into consideration, that Manev would not, to one of ordinary skill in the art, disclose or describe a lithium-manganese complex oxide having a spinel structure according to the present invention, i.e., as a practical matter Manev is directed to an invention which is essentially LiMn_2O_4 .

In this regard, Figures 2A and 2B of Manev which the Examiner has cited are photographs of LiMn_2O_4 , which does not, of course, contain any M in the sense of the present invention.

Thus, even if the particle size of the Manev compound is the same as the spinel structure lithium-manganese complex oxide containing M according to the present invention, the Manev compound is not the spinel structure lithium-manganese complex oxide containing M according to the present invention.

Although the Examiner points out that Manev teaches at column 6, lines 1 to 3, that the particle size of the Manev compound can be controlled to any desired size by grinding, as the spinel structure lithium-manganese complex oxide having a fine particle size of 2 μm or less can

be produced by the rather unique method as described in the present specification, in accordance with the present invention it is unnecessary to control particle size by grinding. Accordingly, Applicants respectfully submit that the present invention is quite different from and distinct from that of Manev.

Further, although the Examiner points out that Manev discloses, at column 7, lines 8 to 12, the half value width of X-ray diffraction peaks of less than about 0.15° for the Manev lithium-manganese oxide spinel compounds, the X-ray diffraction peaks relate to the X-ray diffraction peaks of LiMn_2O_4 which contains no M. Such X-ray diffraction peaks are irrelevant to those of the spinel structure lithium-manganese complex oxide containing M according to the present invention.

A spinel structure lithium-manganese complex oxide containing no M has the following characteristics. A spinel structure lithium-manganese complex oxide having higher crystallizability whose half value width of X-ray diffraction peak is not more than about 0.22° can be easily obtained. However, when M is contained as in the present invention, it is very difficult to obtain a material with a half value width of X-ray diffraction peak of not more than about 0.22° . The lithium-manganese complex oxide having a spinel structure containing M according to the present invention could not be obtained until a uniform mixture was obtained by the "slurry mixing method" and the mixture baked.

Although the Capacity maintaining ratio of discharge capacity at 50°C and the Deterioration ratio thereof are shown in Table 2 of the specification of the present application, deterioration ratios from 10 cycles to 50 cycles are less than 1% in the Examples. Applicants

have reviewed Figure 6 and Figure 7 of Manev, and they have interpreted these Figures of Manev as follows to establish that Figures 6 and 7 of Manev are quite distinct from the present invention. Figure 1 and Figure 2 attached are marked-up copies of Manev Fig. 6 and Fig. 7. Specifically, the Deterioration ratio of discharge capacity due to the discharge at 0.1C in Figure 6 of Manev is as shown in attached Figure 1 and the deterioration ratio is 1.6%, which exceeds 1%. Similarly, the deterioration ratio of the discharge capacity due to the discharge at 0.1C in Figure 7 of Manev is as in attached Figure 2 and the deterioration ratio is 2.0%, which exceeds 1%.

Applicants believe it is quite clear from the above results that a lithium secondary battery wherein a spinel structure lithium-manganese complex oxide containing M according to the present invention is used in a positive electrode is quite superior in electrochemical characteristics to a corresponding positive electrode using any Manev material.

The Examiner has pointed out that substitution of aluminum for M in the formula of Manev would meet the composition limitation in claim 2 of the present application. However, as heretofore discussed, Manev, as a matter of practical substance, describes only LiMn_2O_4 and is silent about any lithium-manganese complex oxide having a spinel structure containing M according to the present invention. Thus, Applicants submit that the spinel structure lithium-manganese complex oxide containing M according to the present invention where M is substituted with aluminum is even more remote from Manev than claim 1 herein is from Manev.

The Examiner has pointed out that Manev describes at column 7, lines 3 to 12 and Figures 6 and 7 that the BET specific surface area for the Li-Mn-oxides of Manev is not more than $0.5 \text{ m}^2/\text{g}$. However, BET specific surface areas of 0.56 and $0.54 \text{ m}^2/\text{g}$ are described in

Figures 6 and 7, and these BET specific surface areas are not more than $0.6 \text{ m}^2/\text{g}$. Such BET specific surface areas themselves would meet the specific surface area limitations in claims 3 and 4 of the present application. However, because the BET specific surface areas are for LiMn_2O_4 containing no M, the BET specific surface areas are not believed relevant to a lithium-manganese complex oxide having a spinel structure containing M according to the present invention.

As discussed in detail above, at best Manev possibly gives a bare chemical formula of what might arguably be considered a lithium-manganese complex oxide having a spinel structure containing M in the sense of the present invention. However, to one of ordinary skill in the art Manev would be taken as discussing, disclosing and describing substantially only LiMn_2O_4 and would be interpreted as silent about any lithium-manganese complex oxide having a spinel structure containing M according to the present invention. Applicants respectfully submit that this would be the case even if the half value width of X-ray diffraction peaks from the (400) plane and the BET specific surface areas of Manev were to be the same as those of the present invention. Nonetheless, Applicants respectfully submit that spinel structure lithium-manganese complex oxides which differ in chemical composition from each other cannot reasonably be compared with respect to physical properties. As a consequence, Applicants respectfully submit that Manev does not disclose nor suggest any lithium-manganese complex oxide having a spinel structure M according to the present invention which would have the physical properties defined in the claims of the present application.

Accordingly, Applicants respectfully submit that that anticipation rejection over Manev is improper and should be withdrawn.

Applicants now address the rejections of claims 1-4 as anticipated by Iwata in view of Manev reserving the right to further traverse the propriety of the Examiner presenting an anticipation rejection based on two references.

Iwata gives $\{\text{Li}\}[\text{Li}_x\text{M}_y\text{Mn}_{(2-x-y)}]\text{O}_{4+d}$, as a spinel structure lithium-manganese-based oxide containing at least one kind of other element (M) other than Li and Mn, wherein the matter inside the $\{ \}$ represents an oxygen tetrahedral site in structure, the matter inside the $[]$ represents an oxygen octahedral site in structure, $0 < x \leq 0.33$, $0 < y \leq 1.0$, $-0.5 < d < 0.8$, and M represents elements other than Li and Mn.

Iwata also discloses that the M elements are at least one element selected from the group consisting of Be, Mg, Ca, Sr, Ba, Sc, Y, Ti, Zr, V, Nb, Ta, Cr, Mo, W, Fe, Co, Ni, Cu, Ag, Zn, B, Al, Ga, In, Si, Ge, Sn, Pb, P, As, Sb and Bi, and that the spinel structure lithium-manganese-based oxide is characterized by an average diameter of aggregated particles of 1 to 50 μm , a BET specific surface are of 0.1 to 5 m^2/g and an average primary particle diameter of not more than 3 μm .

Since Iwata discloses a spinel structure lithium-manganese complex oxide containing M, Applicants believe that Iwata is closer prior art to the present invention than Manev.

However, Iwata is silent about the half value width of X-ray diffraction peaks from (400) plane. The Examiner states that because the half value width is described in Manev, it is clear that the half value width of X-ray diffraction peaks from the (400) plane of the spinel structure

lithium-manganese-based oxide containing M of Iwata is not more than about 0.22° . However, as Applicants have earlier discussed in detail, while Manev describes LiMn_2O_4 , in no fashion does Manev describe, disclose or suggest the lithium-manganese complex oxide having a spinel structure containing M according to the present invention.

As a consequence, Applicants respectfully submit that neither Manev nor Iwata reasonably disclose that the half value width of X-ray diffraction peaks from the (400) plane of the spinel structure lithium-manganese based oxide containing M according to the present invention is not 0.22 or less per claim 1 herein.

The Examiner has pointed out that Iwata recites, in claim 4, a BET specific surface area of 0.1 to $5 \text{ m}^2/\text{g}$, and, accordingly, Iwata discloses a BET specific surface area of not more than $1 \text{ m}^2/\text{g}$ as recited in claims 3 and 4 of the present application. However, although Iwata describes in Table 1 the BET specific surface areas of each Example and each Comparative Example, almost all of the BET specific surface areas are more than $1 \text{ m}^2/\text{g}$ and only the BET specific surface area of Example 6 is $0.90 \text{ m}^2/\text{g}$, which is not more than $1 \text{ m}^2/\text{g}$.

In distinction, the present application discloses, in Table 1, BET specific surface areas of 0.48 to $0.82 \text{ m}^2/\text{g}$. Accordingly, it is quite clear that the BET specific surface areas of the spinel structure lithium-manganese complex oxide containing M according to the present application are smaller than those of the spinel structure lithium-manganese complex oxide containing M as described in Iwata. In Iwata, the BET specific surface areas of the spinel structure lithium-manganese complex oxide containing M as recited in claim 4 herein are only broader than the

actual BET specific surface areas in the Iwata Examples and the like. Iwata actually describes BET specific surface areas larger than the BET specific surface areas of the present invention.

As discussed, although the spinel structure lithium-manganese complex oxide containing M as described in Iwata has the same chemical formula as that according to the present invention, the former spinel structure lithium-manganese complex oxide is quite different in physical properties, in particular with respect to the BET specific surface area, from the latter spinel structure lithium-manganese complex oxide.

Further, taking the Capacity maintaining ratio at 50°C in the case of using the spinel structure lithium-manganese complex oxide containing M as a positive electrode into consideration, all of the Capacity maintaining ratios shown in Table 2 of the specification of the present application are not less than 99%. Applicants have checked Table 1 in Iwata, and note that in distinction, the Capacity maintaining ratios shown in Table 1 of Iwata are not more than 95%. Thus, Applicants submit that it is abundantly clear that the spinel structure lithium-manganese complex oxide containing M according to the present invention is unexpectedly superior, on this record, in battery performance to that of Iwata.

It is believed that this difference is first due to the difference in the BET specific surface area as has earlier been discussed. In addition, it is believed that this difference is further due to the very uniform particle size distribution of the spinel structure lithium-manganese complex oxide containing M according to the present invention, although the particle size distribution is not *per se* in the specification of the present application. However, according to the photograph

in Iwata, (Figure 3 of Iwata), small particles and large particles are mixed and the particle size distribution is not uniform.

It is believed that the differences in physical properties between the present invention and Iwata are due to differences in the method used to produce the spinel structure lithium-manganese complex oxide containing M between the present invention and Iwata. In more detail in Iwata, the spinel structure lithium-manganese complex oxide is produced by mixing a manganese compound, a lithium compound and a compound of M and baking the mixture as described in Paragraph [0032] of Iwata. In distinction, in the present invention the spinel structure lithium-manganese complex oxide is synthesized by producing in advance a complex oxide slurry by adding an alkali to an M salt aqueous solution containing electrolytic manganese dioxide as the manganese material, while stirring the solution, then adding a lithium starting material thereto and then baking the mixture in the air or in an atmosphere of high oxygen concentration. The production method of the present invention is a so-called "slurry solid liquid uniform dispersion method", whereas the production method of Iwata is a mere solid mixing method. Because of the differences between both production methods, it is considered that a spinel structure lithium-manganese complex oxide containing M different from that of Iwata is obtained in the present invention.

Applicants respectfully submit that the rejection of claims 1-4 as anticipated by Iwata in view of Manev is improper, and respectfully request withdrawal.

New claim 19 is added fairly based upon claim 15 setting forth a characteristic of the lithium-manganese complex oxide of claim 1.


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New claim 20 is added fairly based upon the maximum BET value in Table 1 at page 19.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

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